Riparian Restoration of a Reach of the Turtle River Utilizing Soil Bioengineering

By
F. Beaver[1]
M. Johnson[2]
L. Kingery[3]
J. Warne[4]
D. Rush[5]

Correspondence should be directed to Frank Beaver, Department of Geology and Geological Engineering, University of North Dakota, Grand Forks, ND, 58201, USA,
Telephone: 701 777 5294
E-mail: GeoBeaver@aol.com
FAX: 701 777 4449

1. Dr. F. Beaver, P.E. is the Project Engineer for the Red River Riparian Project, an Assistant Professor of Geological Engineering at the University of North Dakota, and President of GeoDynamics Inc.

2. M. Johnson is a Red River Geographic Information Specialist with the Minnesota Department of Natural Resources.

3. L. Kingery is the Executive Director of the Northwest Regional Sustainable Development Partnership.

4. J. Warne is a geological engineering student at the University of North Dakota.

5. D. Rush is the Program Manager for the Red River Riparian Project, Red River Regional Council

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Introduction

Riparian areas have been proven to be crucial to the long-term protection and enhancement of streams, rivers, and lakes in eastern North Dakota. Well-managed riparian zones help provide optimum food and habitat for stream communities, as well as serving as buffer strips for controlling non-point source pollution. Used as a component of an integrated management system, including nutrient management and erosion control, riparian buffers can greatly benefit the quality of the state's surface water resources. The importance of good riparian zone management is becoming more widely recognized.

This paper focuses on riparian restoration and bank stabilization along a short reach of deforested river that was threatening the integrity of a county highway. The Turtle River two miles north of the junction of U.S. Highway 2 and Grand Forks County Road 2 or "as the crow flies," a mile east of Turtle River State Park in North Dakota, changes course abruptly over a distance of approximately one hundred yards from an eastwardly flowing stream to a northwardly flowing stream (Figure 1). The northwardly flowing reach closely parallels Grand Forks County Road 2. Figure 2 shows the cut bank near the highway before restoration.

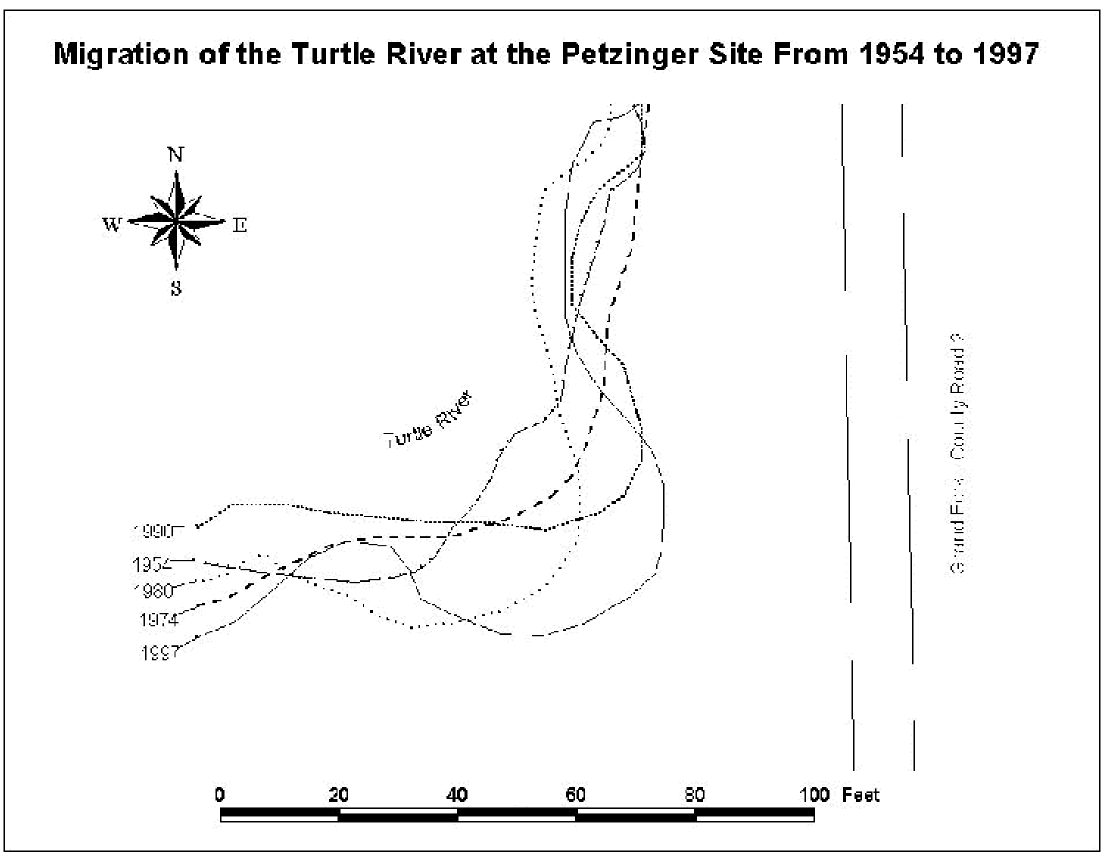

Figure 1: Location of the Turtle River channel in 1954, 1974, 1980, 1990, and 1997. The curved reach of the 1997 channel closest to the road is the restored reach.

Figure 2: The site before restoration.

The area is prime farmland, and for the most part, a buffer of native bottomland hardwoods has been maintained. At this site, however, the loss of woody vegetation left the stream bank vulnerable to severe erosion. The situation was exacerbated by groundwater seeps above the base flow elevation of the river. During the period 1978 to 1995, the river migrated approximately 3.5 feet per year to the east until a fourteen foot cut bank was only 80 feet from the county road right of way. Glacial Lake Agassiz lake plain sediments consisting of silt and clay with some sand comprise the geologic setting. When dry, the sediments have sufficient shear strength to stand in vertical cut banks. However, when they are saturated, these sediments lose shear strength, and collapse readily when undercut by the current along a cut bank. Concern for the integrity of the county road grew but no action was taken because no funds were available for construction.

Project Goal

The goal was to restore and/or improve the condition of this degraded riparian reach and to demonstrate best management practices.

Proposed Design

In order to stabilize the bank and stop further channel migration toward the road, several soil bioengineering techniques were proposed to determine whether this reach of stream with a tight radius bend could be stabilized using soil bioengineering techniques rather than traditional “hard” engineering and construction methods. Soil bioengineering techniques have been developed by the US Army Corps of Engineers, US Department of Agriculture Natural Resources Conservation Service, and others. Experience with their effectiveness in small streams has been limited. A research and demonstration project was designed to determine whether a soil bioengineering approach would be effective, particularly in this reach with the small radius river bend and the engineering characteristics of the geologic materials at the site. Design was carried out in accordance with accepted and newly emerging soil bioengineering principles (Tuttle, 1996; Wells, 1996). A cross section of the reconstructed slope is shown in figure 3.

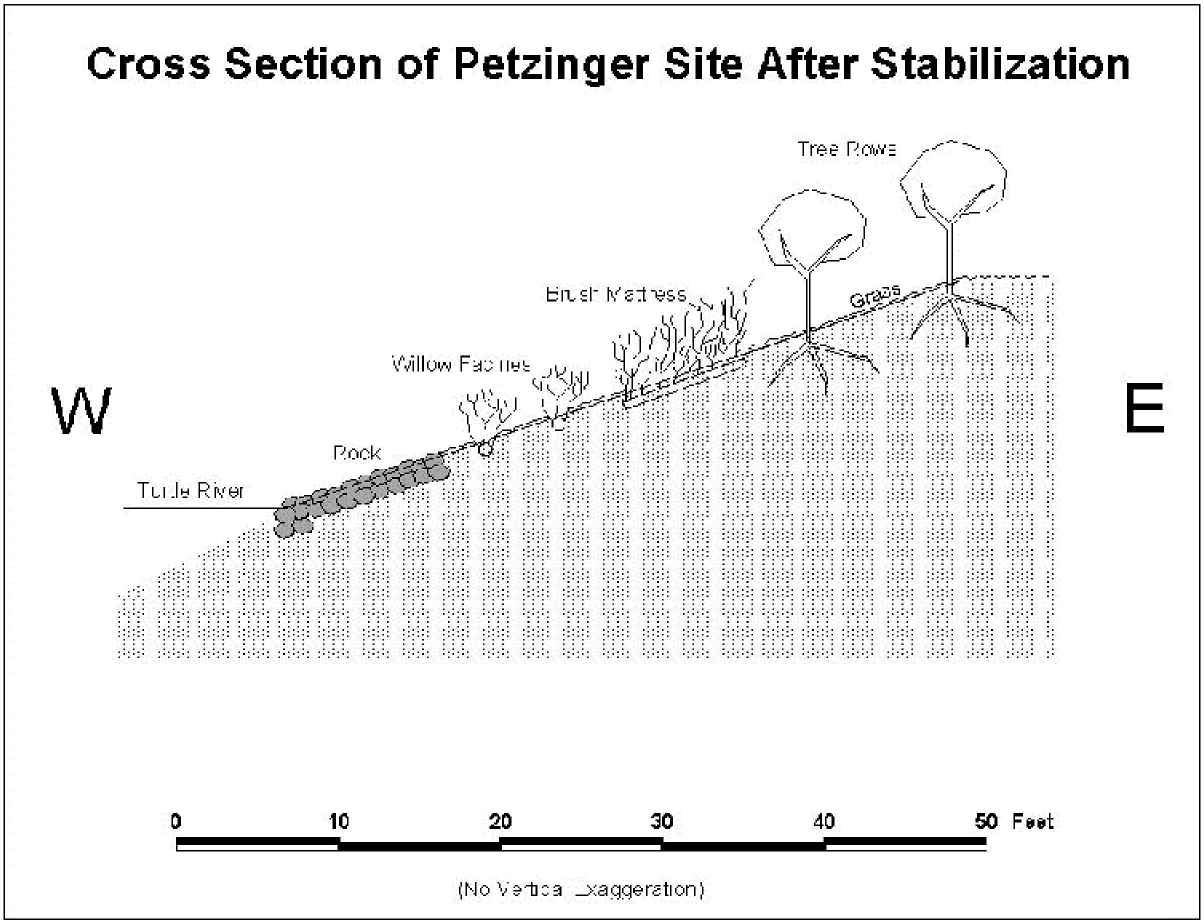

Figure 3: Generalized cross-section of the reconstructed east bank of the Turtle River. Bank full elevation is at the top of the rock armoring. The river level indicated is at low flow but not at the channel bottom. At this level the river is approximately 1 foot deep.

The key design features included:

1) reshaping the fourteen foot cut bank to a 3:1 ratio to provide a stable surface for planting,
2) installing rock armor from the toe of the slope to the bank full elevation.
3) installing willow fascines at the bank full elevation to increase the shear strength of the bank sediments,
4) planting willows to increase the shear strength of the bank sediments, and
5) establishing the site as a riparian restoration demonstration site because of its close proximity of access from the highway.

Construction

The actual installation of the soil bioengineering techniques took place during a training event in October 1995. The soil bioengineering team from Michigan's Natural Resource Conservation Service provided a 4-hour, indoor training session prior to the work on the river. About 70 resource managers from the Red River Basin attended a hands-on training session. Plant Materials Specialist Dave Burgdorf explained that the purpose of bioengineering techniques is to create a stable environment so native species can become reestablished along the treatment area.

The first step was to create a stable slope for the vegetation. The 14-foot vertical bank was reshaped to a 3:1 slope, with the waste from the top being used as fill at the toe. Then, boulder rip rap was installed along the toe to the bank full elevation

A brush mattress to physically armor the bank was installed by placing a grid of stakes in the bank at 2- to 3-foot intervals. After the bank was covered with branches, wire was placed over the brush mattress and wrapped around the stakes to form a network over the mattress. Then the stakes were driven into the bank. Finally, "live" stakes were placed throughout the brush mattress. The brush mattress and fascine were partially covered with soil so that some branches and buds would be exposed to light. A native grass mix was planted above the brush mattress, and two rows of shrubs were planted to complete the project.

The participants then installed a willow fascine in a trench just above the rip-rap. To make a fascine, willow branches 10 to 12 feet long were placed in a series of cross-bucks to form a "rope" about 8 inches in diameter and 30 feet long. Twine ties were secured at 3-foot intervals along the fascine, which was then placed in the trench and secured with stakes. Two wedge-shaped stakes were created by ripping a two foot long 2 x 4 diagonally.

Results

1) Migration of the channel appears to have stopped completely. The 1997 channel shown on figure 1 is also the channel location as of July 2001. Figure 4 is the site after restoration.
2) The high flows experienced in the spring of 1996 tested the site. Erosion occurred along the top of the rip-rap, uncovering and undermining the fascine. The soil was immediately replaced and subsequently washed away during another period of high flow. The site was repaired again by Americorp volunteers in early June 1996. By September 1996 the willow mattress and fascine sprouted prolifically.
3) With the exception of a small washout in the slope face on the downstream end, there has been no further disruption of the slope which subsequently experienced a spring flood in 1997 and a summer flood in 2000.
4) Several episodes of high water combined with browsing by deer and beaver stressed the newly planted seedlings, but the majority of the plants have survived and are growing.
5) The site has been established as a demonstration site for the project and it has been visited by many groups.

Figure 4: The site after restoration.

Discussion

Maintenance is critically important during the initial establishment. The loose fill used at the toe was susceptible to erosion, especially in the first season. The site appears to have responded well to the repair work. The use of root wads should be considered at subsequent sites. Similarly, the use of synthetic mesh may be considered in problem areas.

Soil/plant material contact is best provided by using water to place the soil over the brush mattress and fascine. Installers used a power washer to wash in the soil placed with a track hoe.

Deer and beaver find the willow sprouts irresistible. It may be necessary to use repellants in some cases. At the Turtle River site, time will tell whether the grazing was too extensive for survival.

The small washout in the downstream face of the newly constructed slope is similar to those observed at two other riparian restoration sites. It is possible that a small area of turbulence develops when the flow along the slope encounters increased channel roughness in the form of vegetation when it moves from the slope to the undisturbed bank area. Rock armoring a short distance along the entire slope face may eliminate this feature. An experiment to answer this question is being considered for construction in a subsequent project.

Conclusion

The success of using a soil bioengineering approach for bank stabilization at this site has been demonstrated. The technique has worked in this geologic setting and on a very tight radius curve. If erosion had been allowed to continue, the integrity of the highway would have been in jeopardy within several years. Soil bioengineering provided an effective and aesthetically pleasing solution to this bank erosion problem.

References

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